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Abstract

MEDLI Pressure Port Development for the MSL PICA Heatshield

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The Mars Science Laboratory (MSL) Entry, Descent, and Landing Instrumentation (MEDLI)/Mars Entry Atmospheric Data System (MEADS) project installed seven pressure ports through the MSL Phenolic Impregnated Carbon Ablator (PICA) heatshield to measure heatshield surface pressures during the atmospheric entry phase. The pressure ports were designed to accurately measure the local heatshield pressure while not causing undue harm to the heatshield as a result of aerothermal effects during the MSL Martian atmospheric entry phase. Compliance with these requirements was demonstrated by analysis and through a series of arc jet tests at relevant flight conditions.

Accurately measuring surface pressure through an ablating heatshield during the vehicle entry phase poses many challenges. Since the pressure port must be drilled through the PICA heatshield material there were concerns that pyrolysis gases, as a result of the ablation process, would escape into the pressure port hole, increasing the gas pressure in the port, resulting in an inaccurate reading of the surface pressure. If this was the case, the pressure port would have to be lined with a material or coating that would prevent pyrolysis gases from entering the pressure port path while not adversely affecting the ablation shape or profile on the heatshield surface. Various liner and coating materials were investigated and tested in an arc jet facility in an attempt to meet these requirements.

Another concern was that the pressure port would cause unwanted aerothermal effects resulting in damage to the heatshield, particularly in shearing flow situations. The concern was that the pressure port would increase heating downstream of the pressure port resulting in excessive ablation of the heatshield material. Numerous arc jet tests were performed to evaluate the effects of pressure port shape, size, and relation to the PICA fibers to determine critical parameters for reducing downstream ablation.

This paper will present the pressure port design requirements and concerns and the analysis and test programs that were developed and executed resulting in an acceptable pressure port design that was installed in the MSL heatshield.

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